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Period: 1 July 1954 through 31 December 1955

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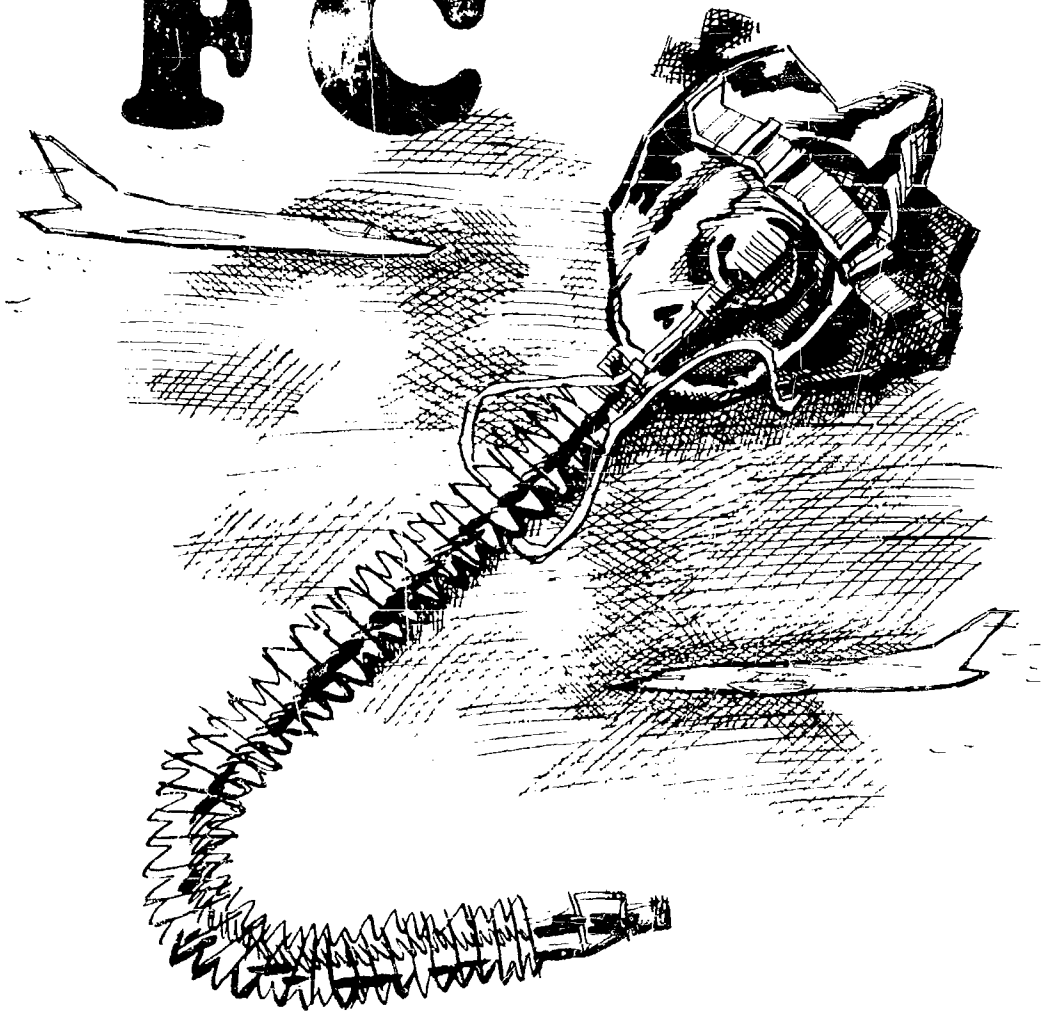

DIRECTORATE of FLIGHT SAFETY RESEARCH
OFFICE OF THE INSPECTOR GENERAL, UNITED STATES AIR FORCE
NORTON AIR FORCE BASE, CALIFORNIA

COPY NO. 1587

HYPOXIA AND UNDETERMINED JET ACCIDENTS

Period: 1 July 1954 through 31 December 1955

by

Captain Eugene B. Konecci

Chief, Physiology & Toxicology Branch

Aero Medical Safety Division

Publication 43-56, 19 October 1956

DIRECTORATE of FLIGHT SAFETY RESEARCH

OFFICE OF THE INSPECTOR GENERAL, UNITED STATES AIR FORCE

NORTON AIR FORCE BASE, CALIFORNIA

SUMMARY

Over a period of 18 months, 1 July 1954 through 31 December 1955, excluding takeoff and mid-air collision accidents, the United States Air Force experienced 194 undetermined major jet aircraft accidents with 206 fatalities. An analysis of each of these accidents indicates that in 32% (59 of 194) hypoxia could have been a possible cause factor. In major aircraft accidents the hypoxia rate per 100,000 flights for all jet aircraft for the same 18 month period was 2.00, i.e., 2.44 for jet fighters, 0.0 for jet bombers, and 1.77 for jet trainers (T-33). Hypoxia rates by aircraft type revealed that the F-80 had a high of 5.78, the F-84 had 3.32 and the F-86 had 2.09. The Flying TAF Non-Fatal Hypoxia Incident Reports for the 1 July 1954 through 31 December 1955 period gave 55 definite hypoxia cases from the 73 submitted reports. All of the Flying TAF incidents were reported in the T-33 aircraft. These hypoxic incidents give some insight into the reasons why and how hypoxia occurs in jet aircraft. Some factors are: improper mask fit; dirty or leaky valves; malfunction of the regulator; separation of the quick disconnect; and loss of cabin pressurization. Recommended corrective action for the prevention of hypoxia episodes, and thereby possible accidents include: (1) stricter oxygen discipline, with frequent inflight oxygen system checks; (2) emphasis on training the jet pilots to check their cabin pressurization and oxygen supply automatically, and as frequently as they do their fuel system; (3) the fostering of a better pilot-flight surgeon relationship to insure the reporting of hypoxic occurrences, resulting in corrective action; (4) insuring a proper fit with a clean oxygen mask; (5) expedite the distribution of the MC-3 connector, quick disconnect oxygen warning device to the field as soon as possible; (6) the utilization by all major commands of a reporting system for hypoxic occurrences similar to that of Flying TAF.

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Prepared By

Aero Medical Safety Division

Directorate Flight Safety Research

HYPOXIA AND UNDETERMINED JET ACCIDENTS

I. PURPOSE

1. The purpose of this study was: (1) to determine the number of undetermined major jet aircraft accidents, excluding takeoff and mid-air collision accidents; (2) to individually screen these accidents for hypoxia as a possible cause factor; (3) to review and consolidate the Flying TAF Non-Fatal Hypoxia Incident Reports in T-33 aircraft; (4) to analyze and compare data for an explanation of a percentage of undetermined accidents; (5) to compute hypoxia rates in jet aircraft per 100,000 flights; (6) to establish recommendations for prevention of future hypoxia accidents, and incidents.

II. CONCLUSIONS

2. It is concluded that:

a. One hundred and ninety-four (194) cause undetermined major jet aircraft accidents (excluding takeoff and mid-air collision accidents) occurred during the period 1 July 1954 through 31 December 1955. In 59 of these cases the altitude prior to the accident and other factors suggested hypoxia as the probable or possible cause. In addition to the 59 there were 22 probable hypoxias in major jet aircraft accidents in which the primary cause was listed as other than undetermined.

b. Seventy-three (73) Flying TAF Incident Reports for the same 18-month period indicated that hypoxia definitely occurred in 55 cases. This shows that hypoxia is a real and frequently occurring phenomenon. On several occasions the presence of a second crewmember in the T-33 aircraft at the time of the hypoxia episode very probably prevented another fatal jet accident.

c. A study of the Flying TAF reports indicated that hypoxia occurs not mysteriously, but rather for definite preventable reasons. These can be briefly summarized as: 33% due to improper mask fit and/or loose or dirty valves in the oxygen masks; 23% due to separation of the oxygen hose quick disconnect; 22% due to defective regulators; and the remainder due to miscellaneous conditions with less than 4% of the causes for the hypoxia being unknown.

d. The Flying TAF Non-Fatal Hypoxia Incident Report is an effective tool in determining and engaging problem areas in hypoxia.

e. Hypoxia episodes occur frequently in the Air Force, especially in jet fighters. However, they are ignored, not recognized, or lead to a fatal accident, hence they are not reported.

f. The major aircraft accident hypoxia rates per 100,000 flights for the same 18-month period mentioned above are as follows: all jet aircraft 2.00; jet fighters 2.44; jet bombers 0.0; and jet trainers (T-33) 1.77. The above rates include the 22 hypoxias in major jet aircraft accidents where the primary cause was listed as other than an undetermined accident. Hypoxia rates computed by the aircraft type reveal that the F-80 has the highest rate of 5.78; the F-84 is next with 3.32; the F-86 has 2.09 and the T-33 has a rate of 1.77 which is below the 2.00 for all jets during the period of 1 July 1954 through 31 December 1955.

g. The hypoxia rates in aircraft which have two or more crewmembers are below the mean average for all jet aircraft. This would indicate that crew oxygen discipline is more effective than that of a solo pilot. The solo fighter pilot is probably too preoccupied with the multiple tasks of flying the aircraft to be fully conscious of the potential dangers of hypoxia.

h. The introduction of new oxygen equipment will not eliminate all of the hypoxia problems. B-57 crews wearing the MC-1 partial pressure suit recently had three hypoxic (non accident) episodes. The cause of the incidents was the disconnecting of the oxygen hose (coming from the face plate) at the quick disconnect position on the manifold block.

i. Defective and malfunctioning oxygen regulators and other oxygen equipment installed in USAF aircraft continue to remain a problem. From 1 January 1955 through 30 June 1956 there were 1,760 Unsatisfactory Reports submitted on all types of oxygen regulators installed in all types of USAF aircraft. The D-2 regulator had the most Unsatisfactory Reports for the period, i.e. 773. The A-14 regulator was the next with 756 Unsatisfactory Re-

ports and the D-1 regulator had 112. The relative inadequacy of the various oxygen regulater types cannot be determined at this time, since information on the total number of each type in service is lacking. The defects in the regulators were primarily leakage of oxygen due to deterioration or rupture of the diaphragm, and/or internal malfunction of the regulator. There were 367 Unsatisfactory Reports submitted on oxygen equipment other than regulators which were installed in USAF aircraft. Unsatisfactory Reports on the oxygen regulators and oxygen equipment installed in the aircraft were submitted at a rate of 16.6 per 100,000 flights for the period 1 January 1955 through 30 June 1956.

III. RECOMMENDATIONS

3. It is recommended that:

a. In view of the large number of possible hypoxias which occurred in major jet aircraft accidents and the 55 hypoxia incidents in T-33 aircraft reported by Flying TAF, greater emphasis should be placed on checking (1) *the fit of the oxygen mask;* (2) *the cleanliness of the mask;* (3) *the operation of the inspiration and expiration valves;* (4) *the oxygen mask and hoses for cracks or other marks of deterioration;* (5) *the proper function of the regulator;* (6) *the oxygen supply;* (7) *the functioning of the cabin pressurization;* and (8) *the security of the oxygen hose quick disconnect.*

b. Increased emphasis be placed on oxygen discipline.

c. Frequent inflight oxygen system checks be re-emphasized.

d. Whenever possible, the flight surgeon, physiological training officer, personal equipment officer, and flight safety officer should make frequent inspections of oxygen equipment and systems, assist in oxygen mask fittings, and establish rapport with the aircrews so that reporting of hypoxia and other unusual incidents will be made immediately without reservation.

e. A plan similar to the Flying TAF Hypoxia Incidents Report, be considered by all commands as a useful means of recording and correcting deficiencies in regard to oxygen systems.

f. The distribution of connector MC-3, stock number 5509-55B3577, quick disconnect oxygen warning device to the field as soon as the engineering change proposal is completed, be expedited.

g. Transition training include instruction in the use and limitations of any new oxygen equipment.

h. Malfunction of defective oxygen equipment installed in USAF aircraft should be reported immediately.

IV. FACTUAL DATA

4. An analysis of the undetermined major jet aircraft accidents, excluding all takeoff and mid-air collision accidents from the computation, for the period of 1 July 1954 through 31 December 1955 is shown in Table I.

5. The total number of major aircraft accidents in the USAF for the same 18-month period was 2,551 accidents, which resulted in 1,220 fatalities and a dollar loss for the aircraft alone of $450,-407,393. Of the 2,551 major aircraft accidents, 19% or 497 were undetermined accidents in all types of aircraft. Of the 497 undetermined accidents, 194 were in jet aircraft, fighters, bombers, and trainers, excluding all takeoff and mid-air collision accidents. In these 194 undetermined accidents 206 fatalities were reported and an aircraft dollar loss of $68,445,049 was sustained.

6. Table I gives an evaluation by aircraft type, listing the number of accidents, the altitude and the possibility of hypoxia as a cause factor. In analyzing the 194 cause undetermined jet aircraft accidents the possibility of hypoxia was determined by taking into consideration: (1) the altitude just prior to the accident; (2) in the unknown altitudes, flight plans generally indicated altitudes above 20,000 feet; (3) maintenance records of faulty cabin pressurization; (4) operating condition of the oxygen equipment as per available records; (5) records of compliance with T.O.s governing inspection and maintenance of oxygen equipment; (6) post accident examination of oxygen equipment; (7) context and voice characteristics of any radio messages just prior to the accident; and (8) any other factors noted in the Form 14, or special investigation which might give a clue to the accident cause. The study of these cause undetermined jet accidents revealed that hypoxia could have been a possible factor in 32%, i.e. 59 out of the 194 accidents. Tab "A" contains six briefs from the 59 possible hypoxia accidents. Table II lists the 194 undetermined jet accidents by aircraft type and model, while Table III gives the fatalities by aircraft type and model.

7. During the same 18-month period, 1 July 1954 through 31 December 1955, Flying TAF reported 73 incidents in the T-33 aircraft of which 55 were definite hypoxic episodes. Table IV gives a breakdown of the causes for the 73 incidents.

Table V is a summary of the specific cause factors for the 55 hypoxic incidents in the T-33 aircraft. It will be noted that over ¾ of the hypoxic episodes were due to the first three causes, i.e. (1) loose oxygen masks and/or defective valves; (2) faulty regulators; and (3) oxygen quick disconnect separation. The causes of only two hypoxia incidents could not be determined. The 73 Flying TAF incidents occurred to seven instructors, two rated pilots, one solo student and the remainder to students flying dual with their instructors. Tab "B" is a sample of a Flying TAF Hypoxia Incident Report. Tab "C" contains two severe and two moderate Flying TAF hypoxia incident briefs. Tab "D" presents the extracted data from the Flying TAF Hypoxia Incident Reports in table form.

8. Probable and possible hypoxias which occurred in major jet aircraft accidents for the period 1 July 1954 through 31 December 1955, were used to compute hypoxia rates per 100,000 flights. Table VI gives the hypoxia rates per 100,000 flights in the various jet aircraft. Rates were computed by individual aircraft type as well as by fighter, bomber and trainer groups. The hypoxia rate for all jet aircraft for the 18 months was 2.00. The F-80 aircraft had the highest rate with 5.78 and the F-84 was next with 3.32. The F-86 was close to the mean average for all jets with a rate of 2.09. The two place F-89 and F-94 aircraft had about half the rate for all jets with 1.01 and 1.24 respectively. The T-33 aircraft was also below the all-jet rate with 1.77. The bombers had no detected hypoxias during the 18-month period under consideration, hence had a rate of zero. However, hypoxia was involved in some minor accidents and incidents of jet bombers. In April 1956, a B-47E aircraft was involved in a major aircraft accident when the pilot became hypoxic due to a deteriorated oxygen mask and no pressurization.

9. The high hypoxia rate for the F-80 aircraft may be attributed to the fact that (1) the majority of the flights were performed by Air National Guard and active or inactive reserve officers not on extended active duty and (2) a large number of Unsatisfactory Reports on the A-14 regulator were from this type aircraft. In addition, it is possible that loss of pressurization played a significant role as a contributing factor.

10. The Training Command flew 1,128,591 flights in the T-33 aircraft for the period 1 July 1954 through 31 December 1955. A hypoxia incident rate of 4.87 per 100,000 flights for the T-33 aircraft was computed, using the 55 hypoxia incidents reported by Flying TAF. This would indicate, that at least in the T-33 aircraft, hypoxia incidents occur about three times as frequently as do possible or suspected hypoxias which are involved in accidents.

11. Table VII gives a summary of the Unsatisfactory Reports submitted on oxygen regulators during the period 1 January 1955 through 30 June 1956. There were 1,760 Unsatisfactory Reports written on all types of oxygen regulators, e.g. 773 on the D-2; 756 on the A-14 and 112 on the D-1. The primary defect in the regulators was oxygen leakage due to (1) deterioration of the diaphragm, (2) rupture of the diaphragm, or (3) some other internal failure. The malfunctioning of the warning light and the flow indicator was also indicated in a number of Unsatisfactory Reports submitted on the D-2 regulators.

12. Table VIII lists the Unsatisfactory Reports written for the period 1 January 1955 through 30 June 1956 on oxygen equipment installed on all types of USAF aircraft and on oxygen service equipment. There were 367 Unsatisfactory Reports submitted for oxygen equipment installed in aircraft. These included deficiencies in liquid oxygen converters, oxygen cylinders, hoses, lines, connectors and valves. As in the oxygen regulators, leakage of oxygen was the prime deficiency in this equipment. However, some reports were concerned with defective or inaccurate aircraft oxygen gages. Unsatisfactory Reports on the ground oxygen service equipment totaled 156 and were submitted mostly on the various oxygen service trailers and hose assemblies.

13. Computation of the rate of Unsatisfactory Reports submitted on oxygen regulators and the oxygen equipment installed in all USAF aircraft, per 100,000 flights was 16.6. The rate is actually higher since the computation was based on all of the flights made in all types of aircraft with or without oxygen equipment, during the period 1 January 1955 to 30 June 1956.

14. One major command in recognition of the hypoxia problem in the T-33 aircraft, has restricted flights of this aircraft to a maximum cabin pressure altitude of 20,000 feet when only one rated pilot is aboard. This decision was based on several non-fatal hypoxia incidents experienced in the T-33 aircraft. One of the hypoxia episodes involved a senior staff officer who was able to recognize the symptoms and recover. On another occasion the pilot was rendered unconscious from hypoxia and a non-rated passenger was able to control the aircraft to a lower altitude where the pilot subsequently recovered.

TABLE I

UNDETERMINED MAJOR JET ACCIDENTS*

1 July 1954 through 31 December 1955

Type Aircraft	No. of Acdts.	Cost in Dollars of Acft.	Fatalities	ALTITUDE IN FEET Altitude in Feet 0 - 9999 Number		10,000 - 19,999 Number		20,000 - up Number		Unknown Number		Total Possible Hypoxic Cases
				Acdt.	Hyp.	Acdt.	Hyp.	Acdt.	Hyp.	Acdt.	Hyp.	
T-33	53	6,334,000	70	11	0	5	1	16	11	21	12	24
F-80	9	913,462	7	3	0	0	0	3	3	3	2	5
F-84	35	14,877,734	36	11	0	6	4	8	5	10	3	12
F-86	70	19,083,237	51	23	0	11	1	19	10	17	5	16
F-89	4	3,623,396	5	1	0	1	0	2	1	0	0	1
F-94	7	3,190,429	13	4	0	1	0	1	0	1	1	1
F-100	6	4,922,052	1	1	0	1	0	3	0	1	0	0
B-47	4	8,309,016	14	1	0	1	0	2	0	0	0	0
B-57	6	7,191,723	9	4	0	1	0	0	0	1	0	0
Total	194	68,445,049	206	59	0	27	6	54	30	54	23	59

*Not including take-off and mid-air collision accidents.

TABLE II

AIRCRAFT DESTROYED BY TYPE AND MODEL IN THE 194 UNDETERMINED MAJOR JET AIRCRAFT ACCIDENTS, EXCLUDING TAKEOFF AND MID-AIR COLLISION ACCIDENTS
1 July 1954 through 31 December 1955

Aircraft Type %	Total Accidents %	Aircraft Model							
		A	B	C	D	E	F	G	K
T-33	53	53							
F-80	9	1		8					
F-84	35				1	4	11	19	
F-86	70	6			30	2	31		1
F-89	4			1	3				
F-94	7		2	5					
F-100	6	4		2					
B-47	4		1			3			
B-57	6	1	3	2					

TABLE III

206 FATALITIES BY AIRCRAFT TYPE AND MODEL IN THE 194 MAJOR JET AIRCRAFT ACCIDENTS, EXCLUDING TAKEOFF AND MID-AIR COLLISION ACCIDENTS
1 July 1954 through 31 December 1955

Aircraft Type	Total Fatalities	Aircraft Model							
		A	B	C	D	E	F	G	K
T-33	70	70							
F-80	7	1		6					
F-84	36				1	3	13	19	
F-86	51	5			18	1	27		
F-89	5				5				
F-94	13		6	7					
F-100	1	1							
B-47	14		3			11			
B-57	9	2	4	3					

TABLE IV

SUMMARY OF ALL THE FLYING TAF INCIDENTS IN THE T-33
1 July 1954 through 31 December 1955

Cause of Incidents	Number
HYPOXIA	55
Hyperventilation	8
Odors in Oxygen System	6
Bends, Altitude 38,000', Cabin 34,000'	1
Other Causes	3
Total	73

TABLE V

SUMMARY OF THE 55 FLYING TAF HYPOXIA INCIDENTS IN THE T-33 AIRCRAFT
1 July 1954 through 31 December 1955

CAUSE OF HYPOXIA	DEGREE OF HYPOXIA	
	SEVERE	MODERATE
1. Loose mask and/or defective valves (e.g. dirty)	1	17
2. Faulty Regulator (leak, etc.)	1	11
3. Oxygen quick disconnect separation	2	11
4. Removal of mask	1	2
5. Improper oxygen settings or cabin pressure	0	2
6. Contamination of oxygen	1	1
7. Leak in tubing	1	0
8. Crimped oxygen hose	1	0
9. Foreign matter in oxygen line	0	1
10. Undetermined	0	2
TOTAL HYPOXIA INCIDENTS	8	47

TABLE VI

MAJOR AIRCRAFT ACCIDENT
HYPOXIA RATES PER 100,000 FLIGHTS IN JET AIRCRAFT
1 July 1954 through 31 December 1955

Aircraft Type	Number of Hypoxias in Major Jet Aircraft Accidents			
	Primary Cause		Total Hypoxias	Rate
	Undetermined	Determined		
T-33	24	9	33	1.77
F-80	5	2	7	5.78
F-84	12	3	15	3.32
F-86	16	7	23	2.09
F-88	0	0	0	0.0
F-89	1	0	1	1.01
F-94	1	1	2	1.24
F-100	0	0	0	0.0
F-101	0	0	0	0.0
F-102	0	0	0	0.0
B-45	0	0	0	0.0
B-47	0	0	0	0.0
B-52	0	0	0	0.0
B-57	0	0	0	0.0
B-66	0	0	0	0.0
All Jet Aircraft	59	22	81	2.00
Jet Trainers (T-33)	24	9	33	1.77
Jet Fighters	35	13	48	2.44
Jet Bombers	0	0	0	0.0

TABLE VII

UNSATISFACTORY REPORTS ON OXYGEN REGULATORS

1 January 1955 through 30 June 1956

QUARTER	OXYGEN REGULATOR TYPE								TOTAL UNSATISFACTORY REPORTS
	A-9A	A-12	A-13	A-14	A-15	A-21	D-1	D-2	
1st, 1955	2	11	0	124	7	15	86	90	326
2nd, 1955	0	4	0	189	13	12	18	183	426
3rd, 1955	0	10	0	167	6	9	4	134	330
4th, 1955	0	5	0	109	1	9	4	138	266
1st, 1956	0	2	0	98	2	3	0	117	222
2nd, 1956	0	2	1	69	3	2	0	111	188
Total	2	34	1	756	32	50	112	773	1760

TABLE VIII

UNSATISFACTORY REPORTS ON OXYGEN EQUIPMENT INSTALLED IN AIRCRAFT AND ON GROUND SERVICE EQUIPMENT

1 January 1955 through 30 June 1956

Quarter	OXYGEN EQUIPMENT		Total URs per Quarter
	Installed on Aircraft	Ground Service	
1st, 1955	22	14	36
2nd, 1955	96	28	124
3rd, 1955	72	31	103
4th, 1955	49	18	67
1st, 1956	39	13	52
2nd, 1956	89	52	141
TOTAL	367	156	523

TAB A

UNDETERMINED JET ACCIDENT BRIEFS

Brief No. 1 F-80C

The pilot was on a routine night navigational training mission. At 25,000 feet the pilot told the flight leader he was tired and was using 100% oxygen. The leader noticed a change in the pilot's voice when he acknowledged the weather. The next and last transmission stated that the pilot was in a spin. Both the aircraft and pilot are missing. The pilot's wallet was found on a beach, and consequently it is believed the pilot and aircraft were lost at sea. Hypoxia was considered as a possible cause factor; the hypoxia probably due to separation of the quick disconnect, faulty hose connection, or poorly fitted mask.

Recommendation was that more emphasis be placed on altitude indoctrination for all pilots, especially those who do not have the opportunity to obtain complete information and training in Air Force flying and ground school activities.

Brief No. 2 T-33A

The pilot was flying on a local daytime proficiency mission (30,000 ft.). No radar or radio contact was made with the pilot. The aircraft was seen in a steep dive, with wings rotating slowly. The T-33 struck the ground at approximately a 60° angle. The duration of the flight was one hour and thirty minutes. The pilot apparently made no attempt to eject. The landing gear, wing flaps, and dive brakes were all retracted. There was no evidence of material failure. There was no indication of an attempt to abandon the aircraft by the pilot. The canopy initiator had not been fired. The ejection seat catapults were flattened by the impact. There was no evidence of an inflight fire. The pilot was fatally injured.

A special investigation revealed that the most probable cause of the accident was that the pilot became physically incapacitated during the flight, from hypoxia or an acute medical catastrophe. The pilot was approximately two months overdue for his annual medical examination. The oxygen mask inspections at the pilot's assigned base were unsatisfactory. Oxygen equipment T.O.s were not being complied with. The pilot's MS-22001 mask was issued on 16 November 1954 and the last inspection was in January 1955. The 30-day inspection on the mask was overdue. It was pointed out that the MS-22001 mask is unsatisfactory in that minute foreign particles can render the mask ineffective.

The recommendations were that increased emphasis be placed on (1) the proper monitoring of medical examinations as prescribed by current directives; (2) proper issue, care and inspection of oxygen equipment; and (3) inflight and preflight checking of oxygen equipment.

Brief No. 3 F-84G

Four F-84 aircraft on a ferry mission were flying at 30,000 feet when No. two man disappeared from formation. Witnesses stated aircraft emerged from clouds in an approximately 50° dive, crashed and disintegrated in the center of a street in a residential area. The accident was fatal to the pilot, one civilian and caused major injuries to four civilians. The pilot's body was found approximately 600 feet from the point of impact. Only minute portions of the helmet were found. Shoulder harness and safety belts were torn from the seat moorings. The fastening buckles were found in the locked position, indicating pilot was still strapped in seat at the time of impact. Since only fragments of oxygen system were found, the board was unable to ascertain whether there was an oxygen system failure or whether the pilot became disconnected from his oxygen supply. Recovered fragments of the high pressure oxygen cylinder show that on impact the cylinder exploded, i.e. the forces were from within to the outside, indicating there was pressure in the cylinder at the time of explosion.

Most probable cause of the accident was listed as hypoxia. The presence of oxygen anti-seize compound and soap solution on the oxygen pressure reducing valve inlet were found and suggest a restriction of the delivery of the oxygen to the pilot.

The pilot had a total of 3842 hours, but only 63 hours in the F-84, with only 6 hours in the last 90 days. The flight leader and one wingman both stated

that the last transmission received from the pilot might have been "weak and strange" or "rather unusual." Shortly after this transmission the No. two man disappeared from the formation and the flight leader's calls were not answered.

The flight surgeon's recommendations were: (1) emphasize and re-emphasize to all pilots the importance of proper fitting and care of oxygen masks and personal equipment; and (2) conduct periodic inspections and tests of oxygen servicing units, storage bottles, and aircraft oxygen systems to insure a pure oxygen supply.

Brief No. 4 F-86A

On a practice combat formation and tactics flight mission, at 30,000 feet No. four aircraft unexpectedly rolled out of formation into a steep right turn. The pilot made no apparent effort to recover from the spin or to eject from his aircraft. Repeated calls to the pilot from the flight leader to eject were unheeded. Thinking pilot had possibly frozen at controls, leader even called procedure to eject; but aircraft continued to spin until it crashed into a snow-covered mountain. Although the aircraft exploded and disintegrated on impact, the pilot's charred torso was found still strapped to the seat.

This Air National Guard pilot had a total of 388 hours with 94 hours and 35 minutes in this model aircraft. A three-month inspection on the F-86 aircraft oxygen system and components had been performed according to T.O. 1F-86-6 on 1 March 1955. T.O. 1F-86-126, dated 1 October 1954, had not been complied with. Form 781-2 of the aircraft showed that the canopy sealing was worked on 10 March because cockpit was not holding pressure. Cockpit altitude should have been approximately 22,000 feet if pressurization was working. Since the flight was at 30,000 feet and if pressurization failed, hypoxia would occur in a short time if another part of the oxygen system had also failed. It is believed that pilot was unconscious during descent. The pilot was well aware and very capable in performing any required corrective action had he been conscious. Hypoxia was suspected as a possible cause. The cause of the accident was listed as undetermined; possible contributing cause, pilot unconscious due to hypoxia or an attack of some kind. Lack of oxygen could have been due to regulator failure or quick disconnect becoming disengaged or separated.

Brief No. 5 F-86E

While flying a routine mission at 35,000 feet, the wingman overshot the leader. The leader rejoined the wingman who had banked right and half rolled to an inverted position. The leader informed him of this fact and the plane was righted. Very little horizon was seen when looking into the sun. The pilot then made a wing over to the right and disappeared into the clouds. No response was received to radio calls. The plane was found completely demolished and parts of the body were recovered approximately 60 hours later. The cause of the accident was undetermined. The Board felt that it was probably hypoxia.

This Air National Guard pilot had a total of 1988 hours, with 350 hours in this model aircraft.

Recommendation was that a study should be conducted for a positive oxygen mask warning light if hose is disconnected.

Brief No. 6 F-80C

The pilot (inactive reserve) departed at 1042 CST on a weekend navigational training flight. Last reported at 1134 CST and declared missing at 1343 CST. The wreckage of the plane was located at 1621 the following day. Investigation revealed that aircraft apparently contacted ground in a vertical dive in excess of 500 miles per hour. Disintegration occurred on impact and ensuing explosion. Pilot's body was disintegrated. There were no signs of the pilot's oxygen mask or helmet. The safety belt was found still fastened. The parachute was blown off during the explosion and the canopy shroud lines and back were found 150 yards away. The aircraft canopy ejection charge and tube were found intact. Parts of the seat ejection system found indicated that it had fired on impact.

Aircraft history revealed that the aircraft was written up five days before the accident because cockpit would not hold pressurization due to failure of the seal. The second flight made on the same day, however, was written up as "OK." The test flight appears to have been performed in a rather haphazard manner since the work sheets were improperly filled out. The pilot's experience in jet aircraft was rather limited. He had a total 36 hours and 45 minutes in jets, all in the T-33 and F-80 type aircraft. The pilot had only flown the F-80 aircraft one hour and 15 minutes in the last 90 days. He had no weather or instrument time in jets. Cause of the accident was undetermined; possible contributing cause factors were listed as hypoxia, possible improper flight planning, pilot may have lacked necessary proficiency for this flight since the cloud top rose abruptly to 41,000 feet on the day of the accident, and he was to fly VFR, 1,000 feet on top.

TAB B

SAMPLE

PART I — **PILOT'S REPORT**

HYPOXIA INCIDENT REPORT
FLYING TRAINING AIR FORCE
AIR FORCE BASE GREEN AF BASE, MISSOURI

REPORT NUMBER 3

Date of incident 7 June 1955 **Type aircraft and number** T-33 472
Time of takeoff 1230 **Time of Incident** 1445
Did you use P. McCripe check Yes **Findings** Mild Hypoxia Incident
Indicated altitude 18,000' **Cabin altitude** was not checked
Type regulator used A-14 **Type mask and size** MS 2200-1 Small
Oxygen system pressure 200 lbs. **Automix and dial setting** Normal/Normal
Which cockpit Front **Dual or solo** Dual

Describe in your own words what happened:

Flying for approximately one hour at an altitude varying from 12,000 feet to 18,000 feet. They went up to 18,000 feet to perform acrobatics and after about 30 minutes cadet noticed he was blacking out much easier than formerly while pulling between 4-6 "Gs". Next he became nauseated but did not vomit. While coming out of a split S he blacked out for approximately 10 seconds. Upon coming out of this, his head was on the side of the cockpit and he felt giddy. Instructor noticed his condition and descended immediately and landed. Cadet began to feel better and nausea left at approximately 5,000 feet so that he landed the aircraft with no difficulty. Check of oxygen hose upon landing showed frayed area with hole in it.

PART II — **FLIGHT SURGEON'S REPORT**

Carbon monoxide determination:
Negative

Any factors predisposing to hypoxia at time of flight:

Check of oxygen equipment prior to flight was normal. No factor predisposing to hypoxia.

Give a word picture of incident from your point of view indicating possible cause of incident:

Slow leak present in oxygen tubing reduced amount of available oxygen to Cadet. The low altitude and cabin pressurization combined resulted in only a small amount of oxygen to be needed by the Cadet. This was the reason the symptoms were present over a 30 minute period of time and were never too severe but were slowly becoming worse and prompt recognition of the condition prevented a more severe case of hypoxia. Symptoms completely cleared up at lower altitude.

/s/t/ John Doe, 1st Lt. USAF (MC)
FLIGHT SURGEON

SAMPLE

PART III **PHYSIOLOGICAL TRAINING OFFICER REPORT**

Helmet type P-3 **Helmet fit** Good

Oxygen mask: type A-13A **Size** _____ **Fit** Good

Date of last fitting 8 June 1954 **Where** Physiological Training Unit
Green AFB, Missouri

Describe anything significant about the mask condition:

Mask was in good condition.

Aircraft: type T-33 **Number** 472

Describe any significant findings from your inspection of the aircraft's oxygen system:

The hole in the regulator hose indicates that the P. Mc CRIPE check was not performed properly although it was signed off in the Form 1. A check of the hose is part of the pre-flight check and the "blow back" check would also have indicated a leaking hose.

Inspected by A/1C James Smith

Date of last physiological training (pilot) June 1954

Number of classroom hours 30 . **Number and type of chamber flights**

Two chamber flights, types I and II.

Describe anything significant in chamber flights

None

Recommendation:

This hypoxia incident indicates that some pilots are making inadequate P. Mc Cripe check or are making the check "on the Form 1" only. It is recommended that this incident be brought to the attention of all section commanders and all concerned personnel be rebriefed on the importance of a complete and thorough check.

/s/t/ JOHN JONES
Captain, USAF
Physiological Training Officer

SAMPLE

PART IV **FLYING SAFETY OFFICER'S REPORT**

Did this incident occur to a student or instructor Student .

Give any information not listed previously which has a bearing on this incident:

No additional information. I have reviewed the report and concur in the findings and recommendations of the Flight Surgeon and Physiological Training Officer.

Recommendations:

The statement of instructor pilot indicates the student made the landing after having been blacked out for a period of 10 seconds. It is recommended that in similar cases the instructor fly the aircraft since the residual effects of the hypoxia are not known shortly after recovery.

/s/t/ JAMES DOE
Captain, USAF
Wing Flying Safety Officer

I have read the inclosed reports and wish to make the following recommendations:

I concur in the recommendations of the Physiological Training Officer and the Flying Safety Officer and have directed action for compliance therewith.

/s/t/ JAMES BLACK
Colonel, USAF
Commander, Green AFB

TAB C

BRIEFS OF FLYING TAF NON-FATAL HYPOXIA INCIDENT REPORTS SUBMITTED ON T-33 AIRCRAFT

Severe Hypoxia

Case No. 1

Prior to takeoff, student pilot in rear cockpit connected his oxygen mask to the system in the recommended manner and made the P. McCRIPE check. At an altitude of 5,000′ the blinker was checked and found to be working. No checks were made of the system at 12,000′ and 20,000′. During the climb the student pilot experienced a slight headache and groggy feeling which he attributed to a cold he had. Shortly after the aircraft passed through 25,000′ the student passed out. His condition was not observed by the instructor until the aircraft was leveled off at 35,000′. The instructor then let down immediately and the student regained consciousness at about 18,000′, being unaware that he had lost consciousness until told by the instructor. On checking the oxygen system he found the quick disconnect to be unplugged. He immediately plugged it in and switched to 100% and breathed 100% oxygen until the aircraft was landed. He was examined by a doctor immediately and his condition was found to be satisfactory.

It is believed that when the student pilot connected the oxygen hose before takeoff, he did not have it fastened securely. Somewhere above 5,000′ the quick disconnect came apart but wasn't noticed because no further oxygen checks were made.

It is recommended that the importance of frequent oxygen checks, while in flight, be re-emphasized to all flying personnel.

Case No. 2

While on a flight at 38,000′ indicated and approximately 32,000′ cabin pressure, the pilot heard a rushing of air normally attributed to mask removal. On checking the passenger in the rear cockpit through his rear view mirror, the pilot noticed that he had removed his mask for the purpose of clearing his nose. The pilot told him not to leave the mask away from his face too long and handed him a benzedrine inhaler with instructions to alternate with whiffs of oxygen. After a few seconds had elapsed the pilot asked the passenger if the use of the inhaler helped his condition. When no response was made the pilot took another look and saw that the passenger's mask was still not connected. The passenger was told to connect his mask but ignored the instructions. The pilot shouted in hopes that he might arouse him to react instinctively, but it was too late. The pilot then reduced the power and hit the dive brake in an effort to maintain a rapid and a controlled rate of descent. The passenger's head fell forward and a slight pressure of his body was felt against the stick, however, it did not affect the pull-out of the aircraft. The nearest base was contacted and informed of the situation and the pilot's intentions to descend and land. As the aircraft reached 7,000′ indicated, the passenger "snapped to life" and fastened his mask. The pilot asked him how he felt and he replied, "I feel real good, in fact, I feel better than I did when we were at 38,000′." Later conversation revealed that the passenger, as he first came to, was trying to figure out what the aircraft was doing at 7,000′ when he knew they were supposed to be at 38,000′. Since the passenger's condition appeared much improved, the pilot momentarily considered the idea of proceeding to his original destination. However, on the basis of previously read incident reports involving poor judgment in such matters, he decided the best course of action was to land the aircraft as planned and obtain a written consent of a flight surgeon before proceeding.

The successful landing was subsequently made and the passenger was examined by doctors and found to have recovered from his hypoxic condition. The flight surgeon replaced him on DNIF for several days due to swollen ear drums which occurred as a result of the rapid descent.

It was recommended that consideration be given to a mandatory requirement that any person experiencing a hypoxic condition be required to land the aircraft and receive written permission prior to any further flying.

Moderate Hypoxia

Case No. 1

Pilot took off on a solo navigation mission and climbed to 30,000′. After approximately 20 minutes of flight at this altitude he noticed a dimming of vision, dizziness and hot tingling sensation of the legs, which were similar to conditions noted in the altitude chamber. He immediately placed the oxygen setting on safety and simultaneously started to descend. The blinker was operating and indicating that oxygen was flowing properly. The aircraft was leveled off at 14,000′ and the pilot switched to the 100% setting. At this time, he noted the oxygen pressure to be 300 PSI and the pressure remained at 300 PSI for the next 10 minutes. He called the control ship informing him of the situation and he was told to return to the field and also to check his cabin pressure. Cabin pressure at 14,000′ indicated was 8,000′. At the 14,000′ level the tingling sensation and dizziness left although his vision was still slightly hazy. A normal landing was made and the pilot's vision improved, however, he still felt weak for a period of two hours after landing. A check of the system after landing disclosed that the pilot's mask was dirty and loose and would not hold safety pressure.

It is recommended that pilots be consistently reminded to keep their masks tight and clean.

Case No. 2

After 30 minutes of flight at an altitude of 30,000′ cabin altitude 20,000′ pilot removed his oxygen mask in order to put his sunglasses on. In approximately 30 seconds after removing his mask, the pilot became definitely groggy due to hypoxia. He immediately notified the rear seat occupant that he was hypoxic and to take over the controls. He was unable to replace his mask until the aircraft descended from altitude. At the lower altitude the hypoxia symptoms were relieved and the pilot replaced his oxygen mask and returned to a pressure setting.

Investigation disclosed that the pilot's oxygen mask was entirely defective. The rubber face piece was rotten and entirely open to ambient air. It is felt that due to the defective mask the pilot was undoubtedly partially hypoxic prior to removal of his mask. The fact that he was able to recognize his symptoms probably prevented a more serious situation. The incident was attributed to: (1) a defective mask and (2) improper procedure at altitude.

It was recommended that this incident be given wide dissemination and that pilots be reminded of the hazard with flying with unfit or unsuitable masks.

TAB D

PERTINENT DATA EXTRACTED FROM FLYING TAF NON-FATAL HYPOXIA INCIDENT REPORTS SUBMITTED ON THE T-33 AIRCRAFT

Period: 1 July 1954 through 31 December 1955

SEVERE HYPOXIA

INCIDENT NUMBER	CABIN ALT. (Ft.)	ACTUAL ALT. (Ft.)	COMMENTS
1	14,000	25,000	Due to anti-seize compound in oxygen system.
2	Not Reported	18,000	Caused by leak in oxygen tubing.
3	19,000	22,000	Student had poor mask fit and exercised poor oxygen discipline.
4	15,000	24,000	Lowering of seat crimped oxygen host restricting the flow of air. Oxygen mask was also slightly dirty and loose.
5	24,000	30,000	Caused by quick disconnect separation in flight.
6	15,000	20,000	Regulator Diaphragm was ruptured; exhalation valve was not properly seated.
7	24,000	35,000	Quick disconnect separated during flight. Frequent inflight oxygen checks not made.
8	32,000	38,000	Removed mask to clear nose, apparently left mask off too long.

PERTINENT DATA EXTRACTED FROM FTAF NON-FATAL HYPOXIA INCIDENT REPORTS SUBMITTED ON THE T-33 AIRCRAFT

Period: 1 July 1954—31 December 1955

MODERATE HYPOXIA

Incident Number	Cabin Alt. (Ft.)	Actual Alt. (Ft.)	Comments
1	Not Reported	25,000	Due to anti-seize compound in oxygen system.
2	Not Reported	40,000	Cause not reported; post-incident check revealed the oxygen system to be normal.
3	Not Reported	30,000	Quick disconnect separated during flight.
4	28,000	40,000	Quick disconnect separation in flight.
5	21,000	21,000	Quick disconnect separated during flight.
6	12,000	20,000	Due to poor mask fit.
7	23,000	30,000	Temporary failure or malfunction of regulator metering system due to dust particles.
8	28,000	40,000	Dirty oxygen mask.
9	17,000	20,000	Poorly fitting helmet and oxygen mask.
10	12,500	18,000-20,000	Regulator Diaphragm ruptured.
11	Not Reported	21,000	Quick disconnect separated during flight.
12	20,000	20,000	Exhalation valve in oxygen mask not fully seated.
13	34,500	37,000	Flew 45 minutes on normal — normal setting with cabin pressure at 34,000-35,000 feet.

MODERATE HYPOXIA (Cont'd)

Incident Number	Cabin Alt. (Ft.)	Actual Alt. (Ft.)	Comments
14	34,500	30,000	Puncture in regulator diaphragm.
15	15,000-18,000	20,000	Quick disconnect separated in flight and slight leak in regulator diaphragm.
16	18,000	20,000	Quick disconnect separated in flight.
17	20,000	20,000	Regulator diaphragm punctured; dump valve for cabin pressurization was open consequently cabin was not pressurized.
18	Not Reported	35,000	Quick disconnect separated in flight, had not been completely seated in C-ring. Improper 5,000, 12,000, 18,000 feet and level off checks.
19	20,000	20,000	Poor cabin pressurization.
20	15,000	22,000	Poorly fitting helmet and oxygen mask; mask would not hold a safety setting.
21	12,500	20,500	Poor mask fit, movement of mask on face evidently allowed ambient air to enter mask. Recommend that mask check be accomplished twice a month by qualified physiological personnel.
22	Not Reported	30,000	Oxygen mask dirty and loose, would not hold safety pressure.
23	18,000	22,000	Poorly fitting mask. Briefings on hypoxia are being given at more frequent intervals in flying training sections as a result of this incident.
24	28,000	30,000	Slight leak in oxygen mask due to inhalation port covers not fitting correctly; regulator probably faulty as pilot could blow back through it.
25	11,500	20,000	Oxygen mask leaked on safety and 41 M settings badly. Inhalation ports were very dirty.
26	28,000-30,000	30,000	Defective fitting mask. Student inadequately briefed resulting in probable improper operation of equipment by student.
27	21,000-23,000	30,000	Defective regulator diaphragm.
28	20,000	30,000	Removed mask to put sunglasses on and became hypoxic in approximately 30 seconds. Apparently slightly hypoxic before removal of mask as rubber face piece was rotten and entirely open to ambient air.
29	28,000	38,000	Regulator leaked on pressure settings. 400 pounds of oxygen used in 1 hour and 20 minutes.

MODERATE HYPOXIA (Cont'd)

Incident Number	Cabin Alt. (Ft.)	Actual Alt. (Ft.)	Comments
30	15,000	26,000	Faulty regulator.
31	14,000	20,000	Leak in regulator hose. Regulator leaked on all settings.
32	17,000	21,000	Poorly fitting and dirty oxygen mask.
33	23,000	30,000	Poorly fitting mask, leaked on all settings.
34	15,000	22,000	Regulator diaphragm ruptured.
35	17,000	26,000	Quick disconnect separated in flight.
36	18,000	21,000	Oxygen exhalation stuck in open position allowing outside air to be inhaled when end of mask hose was shut off.
37	12,000	20,000	Quick disconnect separated in flight.
38	Not Reported	27,000	Regulator was unsatisfactory due to unknown internal factor(s). Regulator hose connection at the ejection seat was found to be slightly loose.
39	14,000	28,000	Student installed expiration valve incorrectly; failed to do P. McGRIPE check before flight and failed to recognize onset of hypoxia even though he gained relief from symptoms three or four times by using 100% oxygen.
40	10,000	25,000	Quick disconnect separated in flight, student failed to connect it properly after checking it.
41	22,000	35,000	Poorly fitting oxygen mask, would not hold a safety setting. Possible bad exhalation valve.
42	16,000	20,000	Oxygen hose accident disconnected where it is spliced to the ejection seat. Post-incident inspection revealed that almost half the T-33 aircraft on the base had an identical improper installation of the oxygen hose on the ejection seat.
43	13,000-14,000	21,000	Regulator did not operate properly.
44	Not Reported	28,000	Pilot removed mask and left it off too long.
45	Not Reported	Not Reported	Red tape was found in oxygen quick disconnect, partially covering oxygen supply line.
46	15,000	21,000	Regulator leaked on safety setting.
47	9,000	18,000-21,000	Cause unknown.

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DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE MATERIEL COMMAND
WRIGHT-PATTERSON AIR FORCE BASE OHIO

FEB 19 2002

MEMORANDUM FOR DTIC/OCQ (ZENA ROGERS)
8725 JOHN J. KINGMAN ROAD, SUITE 0944
FORT BELVOIR VA 22060-6218

FROM: AFMC CSO/SCOC
4225 Logistics Avenue, Room S132
Wright-Patterson AFB OH 45433-5714

SUBJECT: Technical Reports Cleared for Public Release

References: (a) HQ AFMC/PAX Memo, 26 Nov 01, Security and Policy Review, AFMC 01-242 (Atch 1)

(b) HQ AFMC/PAX Memo, 19 Dec 01, Security and Policy Review, AFMC 01-275 (Atch 2)

(c) HQ AFMC/PAX Memo, 17 Jan 02, Security and Policy Review, AFMC 02-005 (Atch 3)

1. Technical reports submitted in the attached references listed above are cleared for public release in accordance with AFI 35-101, 26 Jul 01, *Public Affairs Policies and Procedures*, Chapter 15 (Cases AFMC 01-242, AFMC 01-275, & AFMC 02-005).

2. Please direct further questions to Lezora U. Nobles, AFMC CSO/SCOC, DSN 787-8583.

Lezora U. Nobles

LEZORA U. NOBLES
AFMC STINFO Assistant
Directorate of Communications and Information

Attachments:
1. HQ AFMC/PAX Memo, 26 Nov 01
2. HQ AFMC/PAX Memo, 19 Dec 01
3. HQ AFMC/PAX Memo, 17 Jan 02

cc:
HQ AFMC/HO (Dr. William Elliott)

DEPARTMENT OF THE AIR FORCE

HEADQUARTERS AIR FORCE MATERIEL COMMAND
WRIGHT-PATTERSON AIR FORCE BASE OHIO

NOV 2 6 2001

MEMORANDUM FOR HQ AFMC/HO

FROM: HQ AFMC/PAX

SUBJECT: Security and Policy Review, AFMC 01-242

1. The following material has been reviewed for security and policy IAW AFI 35-101, Chapter 15. It is cleared for public release:

   a. "Investigation of A-4 Sight in F-86E Airplane, 18 July 1952, DTIC No. AD-473 192

   b. Operational Suitability Test of Open Gun Ports for F-86 Aircraft, 31 August 1949, DTIC No. AD-B971 411

   c. Letter Report on Relative Aerial Combat of the F-84E Versus the F086A Capability, 30 January 1951, DTIC No. AD-B971 840.

2. Two reports require clearance from other organizations. Hypoxia and Undetermined Jet Accidents," will be reviewed by 311th Human Systems Wing, and "RCAF Ejection Experience," will be forward to Air Staff for coordination with RCAF.

3. If you have any questions, please call me at 77828. Thanks.

JAMES A. MORROW
Security and Policy Review
Office of Public Affairs

Attachment:
Your Ltr 26 November 2001

26 November 2001

MEMORANDUM FOR: HQ AFMC/PAX
Attn: Jim Morrow

FROM: HQ AFMC/HO

SUBJECT: Releasability Reviews

1. Please conduct public releasability reviews for the following attached Defense Technical Information Center (DTIC) reports:

   a. *Investigation of A-4 Sight in F-86E Airplane*, 18 July 1952; DTIC No. AD- 473 192.

   b. *Operational Suitability Test of Open Gun Ports for F-86 Aircraft*, 31 August 1949; DTIC No. AD-B971 411.

Cleared AFMC 01-259

   c. *Hypoxia and Undetermined Jet Accidents*, 19 October 1956; DTIC No. AD-115 661.

   d. *Letter Report On Relative Aerial Combat Of The F-84E Versus The F-86A Capability*, 30 January 1951; DTIC No. AD-B971 840.

Cleared AFMC 01-260

   e. *RCAF Ejection Experience, 1952-1961*, 1965; DTIC No. AD-465 171.

2. These attachments have been requested by Dr. Kenneth P. Werrell, a private researcher.

3. The AFMC/HO point of contact for these reviews is Dr. William Elliott, who may be reached at extension 77476.

JOHN D. WEBER
Command Historian

5 Attachments:
a. DTIC No. AD- 473 192
b. DTIC No. AD-B971 411
c. DTIC No. AD- 115 661
d. DTIC No. AD-B971 840
e. DTIC No. AD- 465 171